RGC Ref.: X-HKU704/14
(please insert ref. above)

The Research Grants Council of Hong Kong
SFC/RGC Joint Research Scheme
Completion Report

(Please attach a copy of the completion report submitted to the Scottish Funding Council by the Scottish researcher)

Part A: The Project and Investigator(s)

1. Project Title

Biomineralization response of shellfish to global change: biomaterial aspects and applications

貝類對全球變化的響應生物礦化：生物材料方面的應用

2. Investigator(s) and Academic Department/Units Involved

	Hong Kong Team	Scottish Team
Name of Principal Investigator *(with title)*	Dr Vengatesen Thiyagarajan	Prof Maggie Cusack
Post	Associate Professor	Professor and Head of School
Unit / Department / Institution	School of Biological Sciences The University of Hong Kong	School of Geographical and Earth Sciences University of Glasgow
Contact Information	rajan@hku.hk	Maggie.Cusack@glasgow.ac.uk
Co-investigator(s) *(with title and Institution)*		

3. Project Duration

	Original	Revised	Date of RGC/ Institution Approval *(must be quoted*)
Project Start date	01/01/2015		
Project Completion date	31/12/2015		
Duration *(in month)*	12 Months		
Deadline for Submission of Completion Report	31/12/2016		

Part B: The Completion Report

5. Project Objectives

5.1 Objectives as per original application

The primary objective of this complementary approach is to understand the response of commercially important marine shellfish (oysters and mussels) to global climate change scenarios including ocean acidification and warming.

5.2 Revised Objectives

Date of approval from the RGC: NA

Reasons for the change: _____

_____

6. Research Outcome

Major findings and research outcome
(maximum 1 page; please make reference to Part C where necessary)

Major findings and research outcome

Our research strategies, student exchange and joint workshop/symposium organizations have helped to achieve the following research findings and outcomes:

1. Ocean acidification effects on oyster shell mechanical and structural analysis: This joint project yielded two manuscripts, one of them is under review and another one will soon be submitted for publication. These two manuscripts highlights that:

   Crystallographic interdigitation in oyster shell folia enhances material strength (Yuan et al, 2016 – under review)
   Portuguese oysters produce an impaired and a mechanically weaker shell at elevated CO_2 (Yuan et al, 2016 – will be submitted soon)
2. Ocean acidification effects on mussel shell proteome: Mussel shells express unique shell proteome to tolerate and to maintain shell integrity under ocean acidification (Fitzer et al, will be submitted soon)

Thus, this project yielded THREE research manuscripts and two graduate students has got training. One of them was jointly supervised by the two PI's of this grant.
Importantly, this research grant also indirectly helped the University of Glasgow's early carrier scientist who has got training through this grant, Ms Susan Fitzer, to get a prestigious UK Post-doctoral Research fellowship for FIVE years. On the other hand, Miss Yuan Meng of HKU has also got HKU's internal grant to continue her collaboration with UG.

Potential for further development of the research and the proposed course of action
(maximum half a page)

Potential for further development of the research and the proposed course of action

Data generated from this grant application and the collaboration established through this project, have directly helped the HKU's PI (VT) to wrote couple of grant proposals with the University of Glasgow's PI of this grant Prof Maggie as Co-I:

1. GRF Grant application during 2016-17: The grant application title was "Understanding the mechanisms for shell strength in Hong Kong oysters: will the toughest survive climate change?"
2. RGC-Collaborative Research Project (CRP) - preliminary proposal during 2015-16 – which was unsuccessful but will be revised and resubmitted during 2017-2018 – which was titled as "Interdisciplinary solutions to boost the value of oyster aquaculture with sustainability in a changing climate"

This established research linkage between the two PI's also aligned well with the recently established new academic links between University of Hong Kong and University of Glasgow.

7. The Layman's Summary

(describe in layman's language the nature, significance and value of the research project, in no more than 200 words)

Mussels and oysters are widely distributed throughout the globe and are well known to provide direct benefits to mankind as an ecosystem engineer, economic commodity and nutritious delicacy. This shellfish also provide other benefits such as health supplements, natural drugs and their incredibly strong shell architecture have captured the attention of dentists, material scientists and orthopedics. Due to these properties, shellfish production has become a multi-million dollar industry and in many communities an integral part of the local heritage. This precious natural resource is, however, under threat due to ocean acidification. This interdisciplinary collaborative project has identified the interaction between shell calcification and biomechanics of oyster and mussel shells in response to ocean acidification and climate change – to develop oyster or mussel derived biostructures as adhesive construction materials, pollutant adsorbents and scaffolds for bone regeneration. Our results also showed that the Hong Kong oyster is producing a mechanically strong shell, which has applications for biomedical and mechanical engineers to develop new materials.

Part C: Research Output

8. Peer-reviewed journal publication(s) arising directly from this research project

(Please attach a copy of each publication and/or the letter of acceptance if not yet submitted in the previous progress report(s). All listed publications must acknowledge RGC's funding support by quoting the specific grant reference.))

The Latest Status of Publications				Author(s)	Title and Journal/ Book	Submitted to RGC	Attached to this report	Acknowledged the support of this Joint Research Scheme	Accessible from the institutional repository
Year of publication	Year of Acceptance *(For paper accepted but not yet published)*	Under Review	Under Preparation *(optional)*	***bold** the authors belonging to the project teams and denote the corresponding author with an asterisk*)*	*(with the volume, pages and other necessary publishing details specified)*	*(indicate the year ending of the relevant progress report)*	*(Yes or No)*	*(Yes or No)*	*(Yes or No)*

N/A		YES		**Yuan Meng**, **Susan C. Fitzer**, Peter Chung, Chaoyi Li, **Vengatesen Thiyagarajan*** and **Maggie Cusack**	Crystallographic interdigitation in oyster shell folia enhances material strength (Journal of The Royal Society Interface)		YES	YES	NO
N/A			YES	**Yuan Meng,** Abhishek Upadhyay**,** **Susan C. Fitzer**, Chan VBS**,** Kelvin Yeung**, Maggie Cusack and Thiyagarajan V,***	Portuguese oysters produce an impaired and a mechanically weaker shell at elevated CO_2 (Scientific Reports)		YES	YES	NO
N/A			YES	**Susan C. Fitzer**, Dineshram R**,** **Thiyagarajan V, Maggie Cusack***	Mussel mantle proteome response to ocean acidification (Proteomics)		NO	YES	NO

9. Recognized international conference(s) in which paper(s) related to this research project was/were delivered

(Please attach a copy of each delivered paper. All listed papers must acknowledge RGC's funding support by quoting the specific grant reference.)

Month/Year/ Place	Title	Conference Name	Submitted to RGC *(indicate the year ending of the relevant progress report)*	Attached to this report *(Yes or No)*	Acknowledged the support of this Joint Research Scheme *(Yes or No)*	Accessible from the institutional repository *(Yes or No)*

6/2016/Australia	Biofouling in high-CO2 coastal oceans: importance of multiple stressors interactions	4th International Symposium on the Ocean in a High-CO2 World	NO	YES	YES	NO
7/2016/Spain	Interactions Between Organic and Inorganic Materials Across Time and Length Scales	Biomineralization - Gordon Research Conference	NO	NO	YES	NO

10. Student(s) trained *(Please attach a copy of the title page of the thesis.)*

Name	Degree registered for	Date of registration	Date of thesis submission/ graduation
Yuan Meng	Ph.D	01-Jan-2014	31-Dec-2017